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Saranthan et al.

S/N: 09/681,068

**In the Claims**

1. (Original) A method of acquiring free-breathing MR images comprising the steps of:
  - monitoring heart rate of a subject just prior to image acquisition to acquire a time period of an R-R interval;
  - recording the time period from the heart rate monitoring to prospectively estimate future R-R intervals; and
  - acquiring n sets of MR data, a first MR data acquisition commencing at any point in an R-R interval and extending for the time period recorded.
2. (Original) The method of claim 1 further comprising the steps of segmenting each MR data acquisition into n segments and repetitively acquiring each segment in n successive heartbeats.
3. (Original) The method of claim 2 further comprising the step of combining the n MR data sets to form a set of MR images with high temporal resolution covering the R-R interval.
4. (Original) The method of claim 1 further comprising the step of discontinuing heart rate monitoring before acquiring MR image data.
5. (Original) The method of claim 1 wherein a second set of MR data is acquired immediately after the acquisition of the first set of MR data.
6. (Original) The method of claim 2 wherein n=1 for fluoroscopy imaging.
7. (Original) The method of claim 1 wherein the step of acquiring MR data is performed using one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.
8. (Original) The method of claim 1 further comprising the steps of:
  - subjecting a patient to successively increased, graded levels of cardiac stress during the monitoring step until the heart rate is stabilized at a required stress level; and

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acquiring MR data according to the acquisition step of several long and short axis views of at least a portion of a heart muscle to monitor cardiac function during any portion of a stress test.

9. (Original) The method of claim 8 wherein the cardiac stress is induced either by physical stress or administration of a pharmaceutical.

10. (Withdrawn) A computer program for use with an MRI scanner having a computer, the computer program having a set of instruction that, when executed, cause the computer to:

receive a time-period signal indicative of an R-R interval representing a cardiac cycle of a patient;

acquire a first set of partial MR image data during a first acquisition period equal to the R-R interval;

acquire a second set of partial MR image data during a second acquisition period equal to the R-R interval; and

reconstruct an MR image by combining the first set of partial MR image data with the second set of partial MR image data.

11. (Withdrawn) The computer program of claim 10 having further instructions to acquire n sets of partial MR image data, each frame of data in a partial MR data set being acquired at a similar time of a corresponding frame of data in each partial MR data set during the R-R interval.

12. (Withdrawn) The computer program of claim 10 wherein the acquisition of MR data is not gated to an ECG trigger.

13. (Withdrawn) The computer program of claim 10 wherein the acquisition of each set of partial MR data is acquired at a time irrespective of either one of an R-R interval start and end.

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14. (Withdrawn) The computer program of claim 10 wherein each portion of MR data is a segment of an MR data set.

15. (Withdrawn) The computer program of claim 10 wherein one-half of k-space image data for a given segment is acquired during each R-R time period.

16. (Withdrawn) The computer program of claim 10 wherein even and odd numbered lines of a k-space matrix are acquired in successive R-R intervals.

17. (Withdrawn) The computer program of claim 10 having further instructions to monitor heart rate and generate an R-R time period indicative of a current R-R interval in a patient while the MR scanner is idle.

18. (Withdrawn) The computer program of claim 10 having further instructions to periodically monitor heart rate and generate an R-R time period before and after each acquisition of MR data and not during any acquisition of MR data.

19. (Withdrawn) An MRI apparatus to acquire high-temporal resolution images comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to:

monitor heart rate of a patient;

acquire a time period of an R-R interval of the heart rate;

store the time period of the R-R interval;

enable the MRI system and begin an MR scan of the patient at an arbitrary time in the R-R interval;

continue to acquire MR data for a time comparable to the time period stored; and

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reconstruct an MR image with the MR data acquired over at least one R-R interval as estimated by the time period stored.

20. (Withdrawn) The MRI apparatus of claim 19 wherein the computer is further programmed to:

segment data acquisition such that a portion of data is acquired during each acquisition; and

combine the segmented data acquired to reconstruct the MR image.

21. (Withdrawn) The MRI apparatus of claim 19 wherein the computer is further programmed to acquire  $n$  sets of MR data, each having  $m$  frames, where each frame is segmented into  $n$  segments and the  $m$  frames fit within one R-R interval.

22. (Withdrawn) The MRI apparatus of claim 19 wherein the computer is further programmed to apply one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.

23. (Withdrawn) The MRI apparatus of claim 19 wherein the computer is further programmed to acquire one-half of k-space image data for a given segment during each R-R time period.

24. (Withdrawn) The MRI apparatus of claim 19 wherein the computer is further programmed to acquire even and odd numbered lines of a k-space matrix in successive R-R intervals.

25. (Withdrawn) An examination method comprising the steps of:  
subjecting a patient to successively increasing levels of cardiac stress;  
monitoring heart rate;  
once the heart rate is stabilized at a desired stress level, recording a time period of an R-R interval;  
acquiring non-gated MR data using the time period recorded to estimate R-R intervals.

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26. (Withdrawn) The examination method of claim 25 wherein the cardiac stress is induced by one of either physical exercise or administration of a pharmaceutical.

27. (Withdrawn) The examination method of claim 25 wherein the step of acquiring MR data includes acquiring segments of each frame of data over successive R-R intervals.

28. (Withdrawn) The examination method of claim 25 further comprising the step of combining the segments for each frame to reconstruct an image with high-temporal resolution without requiring patient breath-holding.

29. (Withdrawn) The examination method of claim 25 where a fraction of total k-space is acquired during each cardiac R-R interval.

30. (Withdrawn) The examination method of claim 29 where the step of acquiring MR data includes acquiring segments of each frame of data over successive n R-R intervals in order to complete data acquisition for a CINE data set.

31. (Withdrawn) The examination method of claim 30 further comprising repeating the acquisition to provide an updated CINE data set every n R-R intervals.

32. (Withdrawn) The examination method of claim 31 further comprising displaying continuous cardiac wall motion activity in order for an operator to monitor cardiac wall motion in real-time.

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**REMARKS**

Claims 1-32 are pending in the present application. In the Office Action mailed November 5, 2003, the Examiner rejected claims 1-3, 5, and 7 under 35 U.S.C. §103(a) as being unpatentable over Foo (USP 6,078,175) in view of Foo (USP 5,251,628) and Wang (USP 6,198,959). The Examiner next rejected claim 6 under 35 U.S.C. §103(a) as being unpatentable over the modified Foo and further in view of Pele et al. (USP 5,697,370). Claims 8 and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over the modified Foo and further in view of McVeigh et al. (USP 6,171,241). Applicant appreciates the indication of allowability of claim 4.

The Examiner rejected claims 1-3, 5, and 7 under 35 U.S.C. §103(a) as being unpatentable over Foo '175 and Foo '628 and Wang. However, effective November 29, 1999, subject matter which was available as prior art under 35 U.S.C. §103(a) via 35 U.S.C. §102(e), is disqualified as prior art against the claimed invention if the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See 35 U.S.C. §103(c). Since Foo '175 is, at least, available as prior art through 35 U.S.C. §102(e), and in light of the subject matter of Foo '175 and the claimed invention being owned by the same entity or, at least subject to an obligation of assignment to the same entity at the time the invention was made, Foo '175 is disqualified as available prior art. Additionally, Applicant refers the Examiner to the Assignment recorded at Reel/Frame 011507/0733 which evidences assignment of the claimed invention to GE Medical Systems Global Technology Company, LLC. GE Medical Systems Global Technology Company, LLC is a wholly owned subsidiary of General Electric Company, the Assignee of Foo '175.

Given that Foo '175 is disqualified as prior art against claims 1-3, 5, and 7, and further in light of the Examiner's clear admission based on the Examiner's reliance on Foo '175, that Foo '628 and Wang fail to teach or suggest, each and every element of the claimed invention, the rejection of claims 1-3, 5, and 7 under 35 U.S.C. §103(a) cannot be sustained.

Therefore, for at least those reasons set forth above, Applicant believes that which is called for in claim 1, and those claims that depend therefrom, is patentably distinct over the art of record. As a result, Applicant respectfully requests timely issuance of a Notice of Allowance for claims 1-9.

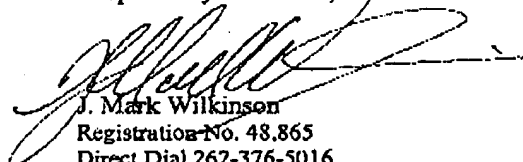
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Additionally, Applicant notes that the Examiner, at page 5 of the Office Action, stated that the prior art made of record and not relied upon but considered pertinent to Applicant's disclosure includes Foo, USP 6,526,307. Applicant is unclear how a patent application filed 10 days after the filing date of the present application, can be considered prior art. Applicant is also filing concurrently herewith a Petition for review of the Restriction Requirement imposed in the Office Action mailed July 15, 2003, and made final in the Office Action mailed November 5, 2003.

Applicant appreciates the Examiner's consideration of these Remarks and cordially invites the Examiner to call the undersigned, should the Examiner consider any matters unresolved.

Respectfully submitted,



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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In an Application of : Sarnachian et al.  
Serial No. : 09/681,068  
Filed : December 19, 2000  
For : Acquisition of High-Temporal Frame-Grabbing MR Images  
Group Art. No. : 3742  
Examiner : Robinson, D.

CERTIFICATION (Sections 97 (c)(1), (2)(a) and 3.10)

I hereby certify that, on the date shown below, this communication is being:

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3) Forwarded by electronic to the file No. 78-872-0006 addressed to Assistant Commissioner of the Patent and Trademark Office.

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AMENDMENT RESPONSE TO 11-05-03 OFFICE ACTION

Dear Sir:

Responsive to the Office Action mailed November 5, 2003, please enter for consideration the following amendments. A current and complete list of the changes is set forth below.